<u>**Future War Concept Paper**</u>

Lesson 7402

"MAKING A QUICK CALL: Compressing Future Military Decision Cycles With Improved Processes and Technology"

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EXECUTIVE SUMMARY

Title: MAKING A QUICK CALL: Compressing Future Military Decision Cycles With Improved Processes and Technology

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Thesis: The U.S. military needs to adopt updated decision-making methods that can fully incorporate cognitive technologies in order to reduce the time requirements of the human participant.

Discussion: Future military operations hold the promise of real-time information gathering and dissemination. Unfortunately, traditional military "industrial age" decision-making processes are incompatible with this change in the informational landscape. The tempo of military operations will continue to be shackled by the speed of human decision-making unless a significant revision occurs. Military decision cycles need to be updated to make them more time-competitive during the compressed activities of future wars.

The U.S. military establishment is following a course to aggressively develop such operational concepts as "Network Centric Warfare" (NCW) and "Rapid Decisive Operations" (RDO). These concepts may create an explosion of data inputs that threaten to overwhelm the military decision framework that traditionally has been organized around the human participant.

During the 1960's and 70's, Colonel John R. Boyd, USAF, endeavored to interpret the mental procedure that a combatant employs to defeat his foe. He originated a construct that is now widely known in the military community as the "Observation-Orientation-Decision-Action (OODA) Loop." Much of Boyd's theory is the basis for our current military aspirations to conduct NCW and RDO. Both concepts require the U.S. military to maintain an asymmetrical advantage over our potential enemies' decision cycles. For this to be realized, the observation-orientation-decision phases of the OODA Loop must be streamlined.

At the heart of the OODA Loop is the "decision." This is the critical event that turns the commander's ruminations into an adopted course of action. Decision-making processes can effectively be categorized into two broad methods: "rational" and "naturalistic." The rational method is a linear process-based approach that seeks an optimized decision. The naturalistic model attempts to quickly arrive at a "satisfactory" solution. Naturalistic decision-making is by its nature more applicable to a time-constrained environment.

The Defense Advanced Research Projects Agency (DARPA) has sponsored a series of experiments / exercises to develop cognitive technologies which can assist the military decision-maker. Some of the cognitive tools currently being developed include: digital battle boards, shared white boards, and integrated force management systems. These devices support the compression of the decision cycle. Future developments in biotechnologies and nano-computers may yield devices that can actually increase the decision-making capacity of a military leader.

Conclusion: Warfare must retain the human participant for it to truly be a mortal endeavor. As the tempo of future war becomes accelerated, the human leader will need to update his decision-making methods in order to remain relevant. The solution to this predicament may lie in changing the manner in which military leaders make decisions. Cognitive technologies such as "expert decision aids" and "immersive virtual reality" may be the instruments to increase man's mental capacity to make rapid and accurate decisions. The future human leader will have to possess the capacity to integrate novel decision-making methods with cognitive technologies in order to achieve an expeditious victory over his foe.

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"Machines don't fight wars, people do, and they use their minds."[1]
Colonel John R. Boyd, USAF

The Problem Defined

Future military operations hold the promise of real-time information gathering and dissemination. The current American use of relatively primitive unmanned aerial vehicles portends a future environment that will be permeated with sensor platforms that can provide the military decision-maker accurate and continuous battlefield information. Unfortunately, traditional military "industrial age" decision-making processes are incompatible with this change in the informational landscape. The tempo of military operations will continue to be shackled by the speed of human decision-making unless a significant revision occurs. Military decision cycles need to be updated to make them more time-competitive during the compressed activities of future wars. Emergent cognitive technologies possess the potential to greatly increase the potency of the human decision-maker. *The U.S. military needs to adopt updated decision-making methods that can fully incorporate cognitive technologies in order to reduce the time requirements of the human participant.* Only by making this type of revision will the human decision-maker remain relevant on the accelerated battlefields of tomorrow.

Tempo in Future Military Operations

The speed of future warfare threatens to outpace the natural abilities of the humans who wage it. The U.S. military establishment is following a course to

[1] John R. Boyd, *A Discourse on Winning and Losing*, August 1987, Private Collections, Master Copy in Library at Marine Corps University, Quantico, VA.

aggressively develop such operational concepts as “Network Centric Warfare” (NCW) and “Rapid Decisive Operations” (RDO). These concepts intend to leverage technological innovation to make American forces more lethal during future conflicts. The desired advantages fall primarily in the information and the command, control, and communications (C3) domains. However, the explosion of data inputs threatens to overwhelm the military decision framework that traditionally has been organized around the human participant. Alan Zimm cogently identified this dilemma:

> In warfare employing TID [total information dominance] and NCW [net centric warfare], data will be as voluminous as that on the movements of the heavens. Unless there is a framework in which to view it, to understand its patterns, and to selectively concentrate on or ignore individual elements, its volume will be debilitating.[2]

An increased quantity of information, combined with a desired elevated tempo of operations, may present an unsolvable conundrum for the military leader. David Jablonsky identified this detrimental condition by observing, “ . . . shorter time for decisions—occasioned by both the compressed continuum of war and electronically gathered information—means less time to discover ambiguities or to analyze those ambiguities that are already apparent.”[3] These factors may cause our decisions, and their resultant military actions, to be dangerously flawed.

To achieve the speed of action envisioned in NCW and RDO, the military will have to reconcile an abundance of information with the need to rapidly arrive at an effective decision. This endstate will require compressed “sensing-decision-action” cycles that can

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[2] Alan D. Zimm, CDR, USN (Ret.), “Human-Centric Warfare,” *U.S. Naval Institute Proceedings*, May 1999, 30.

[3] David Jablonsky, “National Power,” *Parameters* (Spring, 1997), 48.

capitalize on fleeting opportunities on the battlefield. Current military decision-making techniques do not seem able to satisfy the time requirements of this vision.

The Military Decision Cycle

Combat is an innately competitive struggle. Clausewitz called it, " . . . the collision of two living forces."[4] Each opponent in a martial engagement attempts to leverage every possible advantage against his adversary. During the 1960's and 70's, Colonel John R. Boyd, USAF, endeavored to interpret this struggle in the venue of air-to-air combat. He originated a construct that is now widely known in the military community as the "Observation-Orientation-Decision-Action (OODA) Loop" (See Figure 1).[5] This model

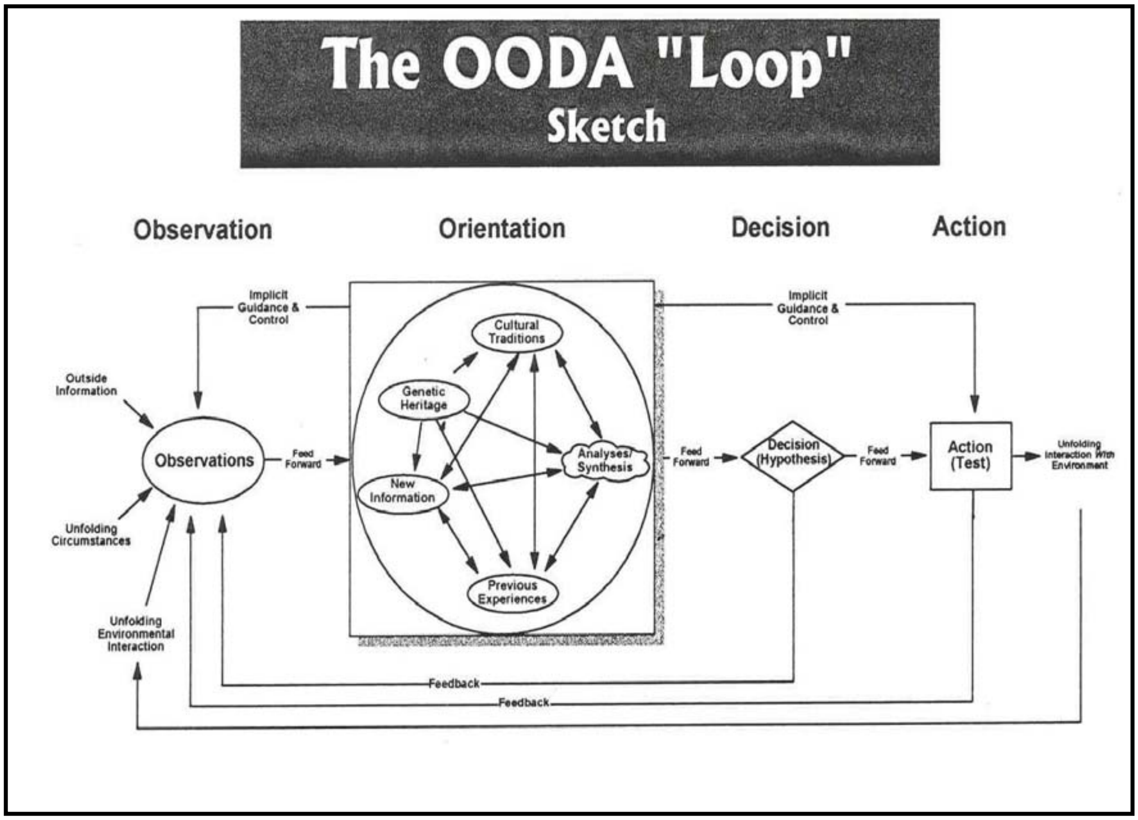

Figure 1

Source: Col. John R. Boyd, USAF, "A Discourse on Winning & Losing."

[4] Carl von Clausewitz, *On War*, trans. and ed. Michael Howard and Peter Paret (Princeton, NJ: Princeton University Press, 1989), 77.
[5] Boyd, n.p.

depicts how a military leader (a fighter pilot in Boyd's original analysis) conducts multiple decision cycles to beat his enemy. Boyd's most important contribution to military theory is his postulation that each combatant will aggressively attempt to " . . . operate inside [his] adversary's observation-orientation-decision-action loops or get inside his mind-time-space."[6] This portion of Boyd's theory is the basis for our current military aspirations to conduct NCW and RDO. Both concepts require the U.S. military to maintain an asymmetrical advantage over our potential enemies' decision cycles. For this to be realized, the observation-orientation-decision phases of the OODA Loop must be streamlined to cause timely action.

<u>Observation – "More Can Be Less"</u>

The commander's view of the battlefield has improved dramatically since the time of Napoleon. In the 18th Century, a military leader had to climb a piece of commanding terrain and view engagements through a magnifying optical device. Today, we have near real-time perception of battlefield events through a host of technological aids that have collectively been titled "Reconnaissance, Surveillance, Target Acquisition" (RSTA). In the future, a proliferation of unmanned vehicles (air and ground), space-based sensors, and improved networking will give leaders (as well as maneuver elements) a continuous stream of accurate "observation" of the battle space.[7] This technology endeavors to give the commander complete awareness and reduce uncertainty to a bare minimum. However, the danger in this approach is that there may be too much data generated for the leader to be able to quickly identify critical events within the

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[6] Boyd, n.p.

[7] The U.S. Department of Defense has recently termed this capability "battlefield persistence."

informational "clutter." We may need to attenuate the sheer volume of observation data in order to focus our decision-making resources.

Orientation – "The Truth Is What We Perceive"

The ability to accurately perceive events on the battlefield and interpret them correctly is a serious challenge for a leader. Military organizations currently trust our intelligence specialists to interpret and analyze battlefield information. They then must make recommendations to the decision-maker concerning the enemy's intentions and methodology. Military intelligence operators are relatively effective in analyzing actions after they occur. Conversely, they find it exceedingly difficult to produce effective "estimative" or "predictive" intelligence (i.e. what the enemy intends to do). They therefore default into reporting on actions that have already happened. This requires the Commander to overlay his judgment, previous experience, analysis, and warfighting ethos in order to interpret how the enemy will fight in the future. This situation does not adequately equip him to make either a timely or a precise decision.

The "Decision"

At the heart of the OODA Loop is the "decision." This is the critical event that turns the commander's ruminations into an adopted course of action. There are numerous techniques that can be employed to arrive at a decision.[8] However, decision-making processes can effectively be categorized into two broad methods: "rational" and "naturalistic."

[8] A U.S. army research report on "battle command" noted, ". . . 66 distinct (decision making) strategies have been documented to date." From Stanley M. Halpin, *The Human Dimensions of Battle Command: A Behavioral Science Perspective on the Art of Battle Command* (Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences), June 1996, 18.

Rational Decision-Making

Today's military leadership is imbued to employ linear decision-making techniques to produce an acceptable solution. This process has been called "Rational Decision-Making" or the "Classical Decision Analysis Method."[9] This philosophy espouses the need to conduct a deliberate sequential examination of all variables and options to produce the best solution. Underlying the techniques to accomplish this analysis is the premise that there is a "best" method in arriving at a decision. The U.S. Army's "Military Decision-Making Process" and the U.S. Marine Corps' "Marine Corps Planning Process" are both examples of current doctrinal approaches for military leaders to arrive at an optimized decision.

Unfortunately, this conventional school of decision-making is not always relevant in a time-constrained environment against an opponent who doesn't employ the same process. Klein cites the work of Zakay and Wooler (1984) who, "found that even when subjects are trained to use analytical decision strategies, they do not apply these strategies when they have a minute or less to make a decision."[10] If most future military decisions are predicted to fall within this time compressed category, then this rational approach will not support the requisite levels of operational tempo.[11] A different decision-making framework should be explored.

[9] Gary Klein, *Sources of Power: How People Make Decisions* (Cambridge, MA: The MIT Press), 1998, 10. Gary Klein uses the term "rational decision-making" or "multi-attribute utility analysis." Klein cites Peer Soelberg's term "Classical Decision Analysis Method."
[10] Klein, 4.
[11] Klein observed that, " . . . fire[fighting] commanders make around 80 percent of their decisions in less than one minute . . . chess players under blitz conditions, where the average move was made in six seconds." Page 4.

Naturalistic Decision-Making

An alternative to arriving at a "rational" decision is a method known as "Naturalistic Decision-Making."[12] Modern cognitive researchers have found that most decisions made under duress employ this type of mental paradigm. This approach attempts to find a suitable solution quickly vice a protracted "best" decision.[13] Leaders using this method rely heavily on intuition and mental simulation. They attempt to recognize patterns in events and "identify leverage points . . . [to] construct a new course of action."[14] The dynamics within this process are non-linear and often produce a decision after the leader employs a host of metacognitive skills.[15] This dynamic is similar to the heuristic manner in which a rock climber scales a cliff face that he has never attempted before.[16]

Expert decision-makers (e.g. those with suitable levels of experience and judgment) find it relatively easy to make naturalistic decisions. They arrive at decisions rapidly and communicate their desires with speed and conviction. Unfortunately, most military leaders are not expert decision-makers. They have limited opportunities to make serious, stressful decisions in a time-constrained environment like that found in combat. Additionally, they are most comfortable with the process oriented decision-making models discussed earlier.[17] This large population of military decision-makers requires

[12] Klein has also called this a "Recognitional-Primed Decision."
[13] Klein notes the work of the Nobel Prize winning economist Herber Simon who coined the term "satisficing." This is in contrast to optimizing a solution. From Klein, page 20.
[14] Klein, 114.
[15] Metacognitive skills are those that arise from "... the ability to consciously monitor one's own thinking process, to choose among alternative problem solving approaches, or to adapt existing approaches to unusual problems." From Halpin, page 17.
[16] An analogy used by Klein.
[17] Halpin also noted in his study that most senior military commanders employed a deliberate decision making process (rational model) when they were required to justify their decisions after making them.

alternative techniques / procedures (as well as technological augmentation) in order to be most effective during rapid operations on future battlefields.

<u>Communicating the Decision – "Causing Action"</u>

Military commanders have always aspired to quickly turn their decisions into action. The development of wireless communication has allowed leaders to communicate their desires to subordinates from afar. However, this conduit has limited potential because it can only operate through the verbal domain (a notoriously inefficient manner in which to convey ideas between humans). Ultra-modern communications has expanded capabilities to include the transmission of digital text files, pictures, and video. In the future, information technology will have to be exploited that can convey the underlying commander's concepts (and intent). This will be the most powerful manner in which to communicate a leader's decision.

<u>Feedback Loops</u>

A critical aspect of the OODA Loop is the iterative nature of its execution. Each episode of observation-orientation-decision-action is permeated with feedback from the previous cycle. It therefore can adjust its action based on this updated knowledge of the situation. This supports an emergent concept of organizational behavior known as "self-synchronization." This theory proposes that organizations can rapidly adjust themselves without guidance from an authority position. The end result is quicker adaptation to dynamic change. Self-synchronization is an essential element of NCW and RDO. It greatly assists a unit in being more agile. The key requirement to accomplish self-synchronization is situational awareness. All members of an organization must have

constant shared awareness of their environment for there to be rapid adjustments. Today's battlefield awareness comes from relatively simple voice / digital reporting and position locating technology. In the future, a more robust mosaic of information must be provided throughout the organization to build environmental understanding.

Modernizing the OODA Loop

The Defense Advanced Research Projects Agency (DARPA) has sponsored a series of experiments / exercises to create an updated Command Post of the Future (CPOF).[18] The intent of this work is to develop future equipment and procedures that can streamline command and control functions for the U.S. military. The centerpiece of this effort has been the development of a "common operating picture" (COP) or what has more precisely been termed a "common relevant operating picture" (CROP). This product is intended to create situational awareness for all members of a unit while reducing uncertainty for military decision-makers. It is designed to filter certain information to reduce the over-saturation of different echelons with information that is not essential to their decision cycles. Although there is a myriad of technical advances being explored, several notable ones hold great hope for the compression of the decision-action cycle.

Digital Battle Board

This device will exponentially increase military leaders' (and their staffs') situational awareness. Current DARPA research considers this technology as its primary deliverable to the U.S. military of the near future. The goal of this tool is to supply "consistent battle space understanding" (CBU) to the human decision-maker. It intends

[18] M. Mitchell Waldrop, "Cutting Through the Fog of War," *Business 2.0*, February 2002, 70.

to provide "a capability to continuously acquire and fuse multi-sensor, multi-source, multimedia data to form a coherent tactical picture. This tactical picture includes awareness of the overall theater and tactical situations of friendly, enemy, and neutral forces . . ."[19] This instrument's power resides in its potential to remove most of the time-intensive actions that consume attention in a command post. The ability to quickly understand the status of all forces in the battle space should enable a decision-maker to compress his decision cycle. However, each leader will want information depicted differently to accommodate his personal data format preferences. These devices must therefore be highly tailorable to the individual user. One drawback to this aid is that it will be limited by the speed of optical processing since its user will still have to observe the information through the visual medium.

Shared White Boards

This tool is a DARPA developed companion to the digital battle board. Its purpose is to support shared understanding of operations and plans. In the same manner as a sports coach uses a black board (or in recent times a "dry erase" board) to depict plays and game strategy, military leaders would use these shared tools to visually depict critical information to subordinate leaders throughout their force. An organization's leaders can monitor operational plans as they mature in order to generate greater parallel planning efforts. This achieves a greater level of collaborative planning where "the impacts of planning at one site are reflected at other sites to support coordination, deconfliction, and group decision-making."[20] This instrument has great potential to

[19] "Technology Descriptions: Decision Making," URL: <www.fas.org/spp/military/docops/defense>, accessed 11 January, 2002, 3.
[20] "Technology Descriptions," 3.

support rapid planning, but it requires all echelons of the organization to possess an integrated and shared philosophy of warfighting. If all elements of the force do not subscribe to the same operational constructs, the information depicted on these instruments may be misinterpreted or incorrectly applied. As in the digital battle board, this device will rely primarily on the visual medium for information transference and can only loosely be termed "virtual" planning.

Integrated Force Management

This system strives to manage and coordinate all actions throughout a military force. Current development has focused primarily on tightening the sensor-to-shooter linkage. "The goal of this effort is to achieve fully synchronized friendly-force situational awareness and coordination, including real-time re-tasking and retargeting . . . between distributed sensors, decision makers, and shooters."[21] This technology is being employed to shorten the time lag between observation and action. Its goal is to expedite the employment of lethal and non-lethal fires to achieve greater desired effects on our opponents' personnel, equipment, and systems. One example of a planned future capability of this system is to produce a " . . . 2,500 sortie integrated ATO [air tasking order] regenerated and retasked at 1-hour intervals . . ."[22] This will undoubtedly contribute to a more agile and responsive military force in the future. However, it is unclear what significant decision-making advantages will come from such potential speed. Although plans will be deconflicted quickly, the commander will still have to be involved in the final review and approval of such products as ATOs.

[21] "Technology Descriptions," 4.
[22] "Technology Descriptions," 2.

Expert Decision-Making Aids

Although still in their infancy, cognitive hardware and software products are being developed to emulate many skills of expert decision-makers. This technology does not aim to fully replicate an experienced military professional, but instead to assist the human decision-maker by autonomously making decisions on tasks which do not require a human "supervisor's" intervention. A recent report described the three characteristics required to automate portions of a system as complex as military operations:

1. A reasonably powerful ability to emulate expert human reasoning/decision-making at a useful level of complexity in hardware/software.
2. The capability for efficiently and effectively providing the right information at the right time to human supervisors in a mode that is relevant to the task at hand in order to effect responsive human supervisory control when and where needed.
3. The ability to monitor and control discrete event-driven processes that are non-continuous in time and inherently non-linear in nature. [23]

The ultimate purpose of such aids is to "optimally distribute decision-making and control between the fully automated elements and the human-directed (i.e. supervisory control) elements."[24] Events such as the rapid identification and engagement of "high value targets," the monitoring of units' logistics levels and conducting re-supply before the requirement is identified, and the positioning of communications assets to ensure seamless command / control are examples of the types of warfighting tasks that could be automated.

Another valuable service that these aids will perform for the commander is their ability to instantaneously wargame / model the results of a selected course of action and

[23] Frank C. Vaughan and Cory C. Sheffer, "An Approach, Using Cognitive Engineering and Modeling Techniques, for Realizing Seamless Human Supervisory Control of Complex, Automated Systems and Enterprises," unpublished report from Johns Hopkins University Applied Physics Laboratory, 2.
[24] Vaughan and Sheffer, 2.

recommend branches / sequels. This provides the military leader a greater capability to accurately weigh his operational options. In its most powerful application, this automated function can monitor currently executed operations and provide real-time feedback to the commander on the potential for success or the need to make timely adjustments to his plan. This effectively allows the human decision-maker to adjust the "round in flight" before his plan encounters an obstacle. Unquestionably, this type of "self-synchronization" would give a U.S. force a huge advantage over future opponents.

Solutions After-Next

Military commanders in the distant future may be part naturalistic decision-maker and part artificial processor. Research into biotechnologies and nano-computers may yield devices which could actually increase the decision-making capacity of a military leader. In a recent article entitled, "The Coming of the Cyborgs," the authors noted the future probability for human use of implanted or appended technologies. They predicted that such devices could make the significant leap from compensating for human loss (i.e. prosthetics) to enhancing human performance. They envisioned technology that could "[s]oon . . . cross the line between repair and augmentation . . . spreading to everyone who wants to make a body perform better than it ordinarily could."[25] No community would be more eager to incorporate such innovation than the military sector.

One way this advanced science could greatly improve a decision-maker is through the insertion of experience and judgment. Today, many military education professionals believe that a leader can vicariously develop these critical decision-making attributes

[25] Gregory Benford and Elisabeth Malarte, "The Coming of the Cyborgs," *Fantasy & Science Fiction*, January 2002, 107.

through the extensive reading of history and the rigorous conduct of decision exercises. It would be extremely empowering to artificially instill these characteristics into a military leader's persona. This would give a relatively junior commander a large reservoir of "virtual" experiences to draw upon. Military leaders could become "expert" decision-makers at the start of their careers.

Cognitive technologies are currently being designed to create such a dream. "Immersive Virtual Reality offers opportunities for experiential encounters with important concepts."[26] This type of technology hopes to remove any perception of the machine-human interface and create, "first-person . . . experience."[27] Not only could this produce a bank of military experiences, it also could enable the commander to have real-time situational awareness. All battlefield data could be instantaneously received <u>and</u> understood. This would provide the commander the maximum time for decision-making and effectively remove the observation-orientation portion of the decision cycle.

<u>**Keeping the Human Relevant**</u>

Warfare must retain the human participant for it to truly be a mortal endeavor. Clausewitz's dictum continues to ring out, "War is thus an act of force to compel our enemy to do our will."[28] Apocalyptic movies such as *Terminator* aside, man will continue to determine the motive for and the scope of war's violence. His role in military decision-making will continue to be essential to monitor and direct hostilities against an

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[26] Tony Greening, "Building the Constructivist Toolbox: An Exploration of Cognitive Technologies," *Educational Technology*, March-April 1998, 29.
[27] Greening, 29.
[28] Clausewitz, 75.

enemy entity. As noted in a recent article in *Parameters*, " . . . the armed forces will want a 'person in the loop' no matter how capable the automated system may become."[29]

Therefore, the challenge remains in how to make the human decision-maker more relevant on the time-compressed battlefields of the future. The answer may partly be through changing the manner in which military leaders make decisions. However, a redesign of how decisions are made will probably not be enough. Ultimately, "[a] long-range solution is to integrate humans and machines in a far more intimate fashion."[30] Cognitive technologies such as "expert decision aids" and "immersive virtual reality" may be the instruments to increase man's mental capacity to make rapid and accurate decisions.

A future military commander may some day be able to sense the battlefield in real-time, instantaneously review a host of operational scenarios, filter his memory banks for important patterns of past activity, quickly review levels of resources, and communicate his wishes at light speed. However, that leader will still have to make the ultimate critical decision on how, where, and when to send his soldiers, sailors, airman, and Marines into harm's way. As accurately stated in a recent report, " . . . there will always remain a set of elements at the top of the decision-making hierarchy that are not amenable to machine implementation and which, therefore, must be addressed by the human decision maker."[31] The future human leader will need to possess the capacity to integrate novel decision-making methods with cognitive technologies in order to achieve an expeditious victory over his foe.

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[29] Thomas K. Adams, "Future Warfare and the Decline of Human Decisionmaking," *Parameters* (Winter 2001-02), 64.
[30] Adams, 68.
[31] Vaughan and Sheffer, 1.

BIBLIOGRAPHY

Primary Sources

Boyd, John R. *A Discourse on Winning and Losing*, August 1987. Private Collections. Master Copy in Library at Marine Corps University, Quantico, VA.

Secondary Sources

Adams, Thomas K. "Future Warfare and the Decline of Human Decisionmaking." *Parameters* (Winter 2001-02), 57-71.

Alberts, David S., John J. Garstka, and Frederick P. Stein. *Network Centric Warfare: Developing and Leveraging Information Superiority*. 2d ed. rev. DoD C4ISR Cooperative Research Program Publication Series. Washington, DC: GPO, August 1999.

Clausewitz, Carl von . *On War*. Trans. and ed. Michael Howard and Peter Paret. Princeton, NJ: Princeton University Press, 1989.

Geva, Nehemia and Alex Mintz, eds. *Decision-making on War and Peace.* Boulder, CO: Lynne Rienner Publishers, Inc., 1997.

Greening, Tony. "Building the Constructivist Toolbox: An Exploration of Cognitive Technologies." *Educational Technology*. March-April 1998, 23-35.

Halpin, Stanley M. *The Human Dimensions of Battle Command: A Behavioral Science Perspective on the Art of Battle Command*. Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences, June 1996.

Jablonsky, David. "National Power." *Parameters* (Spring, 1997), 34-54.

Klein, Gary. *Sources of Power: How People Make Decisions.* Cambridge, MA: The MIT Press, 1998.

Schmitt, John F., and Gary Klein. "How We Plan." *Marine Corps Gazette*, October 1999, 18-26.

Smith Jr., Edward A. "Network Centric Warfare: Where's the Beef?" URL: <http://www.dodccrp.org>. Accessed 14 October 2000.

"Technology Descriptions: Decision Making." URL: <www.fas.org/spp/military/docops/defense>. Accessed 11 January, 2002.

Vaughan, Frank C. and Cory C. Sheffer. "An Approach, Using Cognitive Engineering and Modeling Techniques, for Realizing Seamless Human Supervisory Control of Complex, Automated Systems and Enterprises." Unpublished report from Johns Hopkins University Applied Physics Laboratory report. No date.

Waldrop, M. Mitchell. "Cutting Through the Fog of War." *Business 2.0*, February 2002, 70-74.

Wass de Czege, Huba, BGen, USA (Ret.) and Major Jacob D. Biever, USA. "Future Battle Command: Where Information Technology, Doctrine and Organization Meet." URL: <http://www.ausa.org/www/armymag.nsf>. Accessed 6 March 2002.

Zimm, Alan D., CDR, USN (Ret.). "Human-Centric Warfare." *U.S. Naval Institute Proceedings*, May 1999, 28-31.